

A Monitoring and Reporting Strategy for the Dairying and Clean Streams Accord

**Measuring the Environmental Outcomes
of Implementing the Accord**

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1 Summary

This is a recommended Monitoring and Reporting Strategy for the Dairying and Clean Streams Accord. It follows from discussion by the Accord partners (Fonterra, 13 regional authorities, the Ministry for the Environment (MfE) and the Ministry of Agriculture) of a draft strategy prepared by Environmental Management Services Limited, followed by further discussions with MfE and the other Accord partners.

There are five separate elements to the Accord. In broad terms these are that dairy cattle be excluded from larger streams, that regular dairy crossings be bridged or culverted, that all dairy farmers comply with resource consent or permitted activity standards, that all dairy farmers carry out nutrient budgeting, and that all regionally significant wetlands on dairy farms be fenced out.

Present reporting on progress towards meeting the agreed targets for each of those five elements of the Accord is primarily by farmer self-reporting, with some auditing carried out on behalf of Fonterra.

Some of the Accord targets, however, are not well defined, and so are open to different interpretations. This report recommends measures to better define those targets. It also promotes some independent monitoring by regional authorities that will give greater credibility to the results on implementation of Accord targets reported by farmers and Fonterra. Fonterra have indicated that they agree with the recommendations in this report and the process whereby these recommendations may be incorporated into improving the measurement of progress towards Accord targets. Accordingly, we are confident that future reporting on progress towards Accord targets will be more reliable and credible.

Twelve of the 13 regions in which Fonterra operates have prepared Regional Action Plans to define how the Accord partners (Fonterra, the regional authority, and sometimes Federated Farmers) will make progress towards implementing the Accord. Most of those Regional Action Plans follow a similar template. Three councils – Taranaki, Marlborough and Otago – have used the plans to look more broadly at the impacts of dairying on the environment. At the time of writing, no Regional Action Plan explicitly addressed monitoring the environmental outcomes of implementing the Accord.

It will be difficult to link the implementation of the Accord with measurable effects in watercourses. A large number of factors affect water quality and biota in streams, and it will not be easy to separate what might be the relatively minor benefits of implementing the Accord from the background ‘noise’ due to all other factors. Certainly both national and regional level datasets are far too general to separate out the benefits of implementing the Accord from all the factors, including land-use activities, that impact on water and habitat quality in rivers and streams. However, it is considered that the recommended strategy will be able to provide a more thorough picture of Accord benefits for receiving waters.

For the last six years Dairy Insight, the Sustainable Farming Fund and participating regional councils have carried out extensive work in four best practice dairy catchments. These are the Toenepi in the Waikato, the Waiokura in Taranaki, the Waikakahi in South Canterbury and the Bog Burn in Southland. Studies have included intensive work on water quality, soil quality and farm management. The work done in these catchments has been summarised, and it is recommended that the current monitoring be reviewed to see how it can be modified to assess the environmental benefits of implementing the Accord. In saying this, it is noted that in those

catchments good progress has already been made towards achieving Accord targets, such as the fencing out of streams and nutrient management, and other best management practices are being implemented. Accordingly, it will not be easy to separate out the benefits of implementing the Accord in those areas.

The main proposed thrust of this strategy is to develop over time reasonably intensive monitoring programmes in up to 10 representative watercourses around the country to monitor the environmental benefits of implementing the Accord (and indeed other improved practices in dairying catchments). Where possible, these programmes build on existing State of the Environment (or other specific monitoring) carried out by regional authorities. Staff in regional authorities proposed particular catchments in their region, which are referred to as second-tier catchments. These were filtered through five criteria to assess suitability:

- the nature of the catchment (it should not be too large and should have a defined reach predominantly in dairying)
- implementation of the Accord should not be too far progressed
- ideally existing water and habitat quality will be degraded so that benefits can more readily be measured
- there is good knowledge of land use in the catchment
- ideally there will be existing information (such as from State of the Environment monitoring programmes) on water quality, biota and flows.

In these catchments a very good understanding will be needed of their general characteristics (such as stream type, underlying geology etc),¹ land use and progress towards meeting the Accord targets. Extensive water quality monitoring on a monthly basis is required at several sites in each catchment, at least one of which is upstream of any influence of dairying. The strategy makes recommendations as to what parameters need to be monitored. If possible, more intensive water quality and biological monitoring should be undertaken in summer when the benefits of implementing the Accord are likely to be greatest. It may be possible to collect intensive information for one year and then reduce the intensity of the monitoring programme for several years, prior to undertaking intensive monitoring again. Intensive monitoring is recommended to be undertaken at least one year in four, however, so any long-term trends can be picked up.

It is likely to take at least five years, and more likely 10 to 15 years, before definitive trends can be confirmed.

The exact detail for how any proposed monitoring could be carried out in individual rivers and streams has not been specified in this strategy. Rather, the most likely candidate catchments are listed. Final monitoring design will be the responsibility of the relevant regional authority.

A third limb to the strategy is also recommended. It would involve specific case studies looking at the benefits of implementing the Accord, or an element of the Accord, on one to two properties. These case studies could, for example, study the benefits of bridging a frequently used crossing, or a range of interventions on a single property. Such studies already exist, although at this stage they have not been reviewed in detail.

¹ Some of this will be available through the Regional Ecotype Classification (REC) database held by MfE.

This report recommends that results from the intensively monitored catchments be collated every five years starting in 2012. It also suggests how the results from these catchments may be able to be aggregated or extrapolated to indicate national trends (although much caution will need to be applied in any such exercise because of the small 'sample' available).

Finally, in carrying out this work it is recognised that the Accord will be only a first step, and that there are many other interventions that can help minimise the effects of dairying on the environment. Many of these are already showing very promising results. They include, for instance, the use of low-pressure irrigation systems for effluent disposal, and the use of nitrification inhibitors to reduce nitrate-nitrogen contamination of groundwater. Where these have been identified they are listed in section 9 of this report, for consideration as priorities for future educational or extension activities by Fonterra.

A full list of recommendations is in section 10 of this report.

2 Introduction

2.1 The Dairying and Clean Streams Accord

The Dairying and Clean Streams Accord ('the Accord') was agreed between Fonterra Co-operative Group (which comprises over 95 percent of New Zealand's dairy industry), the Minister for the Environment, the Minister of Agriculture, and regional councils in May 2003. The Accord reflects a commitment by these parties to improve the environmental performance of dairying, and has a goal of achieving 'clean healthy water in dairying areas'. The parties to the Accord agreed to work together towards developing practical solutions to protect and enhance water quality in dairying areas.

The Accord comprises five elements as follows:

Table 1: Elements of the Dairying and Clean Streams Accord

Accord objective	Accord national target
Dairy cattle are excluded from streams, rivers, lakes and their banks.	Dairy cattle are excluded from 50% of streams, ² rivers and lakes by 2007, 90% by 2012.
Regular (more than twice a week) crossing-points have bridges or culverts.	50% of regular crossing-points have bridges or culverts by 2007, 90% by 2012.
Farm dairy effluent is appropriately treated and discharged.	100% of dairy farm effluent discharge complies with resource consents and regional plans immediately.
Nutrients are managed effectively to minimise losses to ground and surface water.	100% of dairy farms have in place systems to manage nutrient inputs and outputs by 2007.
Existing regionally significant or important wetlands (as defined by regional councils) are fenced and their natural water regimes are protected.	50% of regionally significant wetlands fenced by 2005, 90% by 2007.

The Accord was agreed in response to increasing public and industry awareness of the detrimental environmental effects of land-use intensification, particularly dairying. Fish and Game New Zealand led an awareness-raising campaign that became known as the 'Dirty Dairying Campaign'. The campaign followed a time when there had been significant development of dairying in areas that were traditionally non-dairying areas (e.g. Canterbury and Southland). The dairy industry recognised the need to maintain a competitive global advantage that is built upon marketing products seen as being produced in a 'clean and green' environment.

² A stream is defined under the Accord as being a stride wide and a 'red band' deep or larger. In other words, about one metre wide and 15–20 cm deep.

2.2 Implementation of the Accord

Fonterra report that, as of the 2004/05 dairy season, progress towards Accord targets is as follows (the information presented excludes the Taranaki region):³

- Seventy-two percent of Fonterra suppliers have waterways that meet the definition in the Accord. The highest proportions of farms with Accord waterways are in Marlborough and Southland, with over 80 percent of farms including such waterways. On average each farm with Accord waterways has about five to six km of stream banks (i.e. on both sides of the stream) from which stock should be excluded.
- Of the Fonterra farms with Accord waterways, 55 percent now have stock excluded from those waterways. This means the 2007 target of 50 percent stock exclusion has already been met. Including those farms with no Accord waterways, 72 percent of suppliers have stock fully excluded. This proportion is highest in Auckland, Northland, Canterbury, Otago and Southland, and lowest in Wellington, Tasman and Marlborough.
- All but 400 (7 percent) of the 5612 crossings in the nation are bridged or culverted. The 2012 target of 90 percent of stock crossings bridged or culverted by 2012 has already been met.
- Although no data are presented, the target of 100 percent of farm dairy effluent discharges complying with resource consents and regional plans has not been met.
- Nationally, only 19 percent of dairy farms have a nutrient budget included in their fertiliser programme. This is only 2 percent up from the 17 percent reported in the previous year. However, the two large fertiliser companies have indicated they will provide a nutrient budget for all their clients, and Fonterra are working with Dexcel to increase farmer awareness of nutrient management. The target of 100 percent of suppliers having systems in place to manage nutrient inputs or outputs by 2007 remains a distant goal at this time, but Fonterra are confident they will at least come close to meeting it.
- In the three regions where regionally significant wetlands have been identified, the 2007 target of 90 percent of such wetlands being fenced out has been met.

In conclusion, progress towards the waterway stock exclusion and bridging/culverting targets is very good, but the nutrient budgeting target is lagging behind at present.

³ Fonterra Co-operative Group Limited, 2004/05 Environmental and Animal Welfare Assessment.

2.3 Roles of Accord partners

There are 12 regional councils and four unitary authorities in New Zealand. Collectively known as regional authorities, these councils are responsible for water resource management and management of all discharges to the environment in their respective regions. Regional authorities are the regulators who control the environmental effects of activities undertaken by dairy farmers.

Thirteen of these 16 regional authorities have significant numbers of Fonterra dairy suppliers in their region, varying from 62 and 75 in Hawke's Bay and Marlborough respectively, to over 2,000 in Taranaki and over 4,400 in the Waikato. The three exceptions are the Gisborne District and Nelson City unitary authorities, which have virtually no dairying, and the West Coast region, where Westland Dairy operate and the Accord does not apply.

Of the 13 regions with Fonterra suppliers, 12 have now completed a Regional Action Plan (RAP). The exception is Environment Bay of Plenty, who are intending to prepare an RAP in line with their Proposed Regional Water and Land Plan.

The RAPs cover details of council-led regional programmes that aim to encourage farmers to implement good farming practice in line with the Accord's objectives. Examples of these programmes include provision of advice, encouragement of best management practice (BMP), incentive and funding schemes for riparian tree planting and planning/planting assistance for farmers whose properties border significant wetlands. The plans also commit Fonterra and regional authorities to carry out particular actions in each region.

Most RAPs follow a template approach promoted by Fonterra for the five elements of the Accord. Different approaches have been used in the Taranaki and Otago regions, and the RAP for the Marlborough District focuses on stream crossings. In Otago, a Memorandum of Understanding has been developed that sits alongside the Accord dealing with the effects of mole and tile drains.

The 12 RAPs outline how progress towards meeting Accord targets will be monitored. This focuses, however, on the measurement of the five 'inputs' to the Accord, as listed in Table 1 above. There was no requirement in these first plans to monitor the environmental benefits of implementing the Accord.

This Strategy sets out a programme to assess the environmental outcomes of the Accord.

2.4 Present monitoring of Accord progress

The current monitoring of the Accord is focused on assessing progress against the five on-farm management practice 'inputs' specified in the Accord itself. Compliance with the third target (appropriate treatment and discharge of dairy effluent) is generally assessed through the routine compliance monitoring actions of regional authorities. There is no direct monitoring of the possible environmental outcomes of implementing the Accord.

The present monitoring of the Accord inputs is predominantly undertaken by two independent assessors, Agri Quality and Quality Consultants New Zealand (QCONZ), carrying out a verbal assessment at the time of Fonterra suppliers' annual farm dairy assessment. These two companies have existing relationships with farmers as they are contracted by Fonterra to report on the management of milk quality.

This information is then collated on a regional and national basis by Fonterra. There are two complete data sets, for the 2003/04 and 2004/05 seasons respectively. A report has been prepared for each data set and is circulated to all Accord partners. Summary statistics and relevant regional information is also supplied to other stakeholders at Fonterra's discretion.

Early in 2005, Fonterra contracted three independent assessors to undertake auditing of the farmer-generated information collated by Fonterra in the Waikato, Canterbury and Northland regions. Seventy independent on-farm assessments were carried out in the Waikato, and 20 in each of the other regions.

The results of this independent audit are detailed in the 2004/05 annual report. All three assessors believed the results of the audit supported continued verbal assessment. Areas of discrepancy were in the cases where farmers were asked to estimate figures, and occasionally where a farmer had misinterpreted a question.

In discussions with regional authority staff, a number of options were explored as to how this independent auditing should occur and who should undertake it. Some councils already did elements of their own independent auditing, particularly relating to matters such as fencing out of streams. Some councils expressed concerns that if they undertook auditing, this would conflict with their regulatory and/or extension roles.

Overall, there was general agreement there needed to be some selected independent auditing of verbal reporting currently underway. Furthermore, the need for, and scope of, this independent auditing will also need to be reviewed on a regular basis.

3 This Project

The main elements of the project brief are in Appendix 1 to this report.

3.1 Methodology

In carrying out this work, a wide variety of people were consulted, including staff of regional authorities, Fonterra staff, and many of the scientists undertaking work on the effects of dairying.

A structured interview was carried out with the regional authority staff member responsible for preparing and implementing the RAP in each of the 13 regions covered by the Accord. These people were often interviewed in conjunction with a water quality scientist or science manager.

A number of scientists who have participated particularly in studies in the four best practice dairy catchments were also spoken to. These included representatives of Fonterra, NIWA, AgResearch, Dexcel and Lincoln University. Published information and unpublished reports from the four best catchment studies were reviewed.

Bryce Johnson, Executive Director of Fish and Game New Zealand, was also interviewed.

Summary information from the interviews with regional authority staff and from the four catchment studies is given in Appendices 2 and 3.

4 Measuring Progress Towards Meeting the Components of the Accord

The monitoring strategy has been developed to provide recommendations in two broad ways. These are to:

- outline nationally consistent measures of progress towards meeting the targets of the components of the Accord (or inputs)
- provide means of measuring the environmental outcomes of implementing the Accord.

This present section deals with measuring the inputs of the Accord, and what the environmental outcomes of implementation should be. How the overall outcomes of the Accord may best be measured is discussed in section 5, with further detail provided in section 6.

4.1 Challenges and assessment criteria

In suggesting an agreed approach to measure progress towards meeting Accord targets, there are two main challenges to overcome:

- The Accord is worded in very simple terms and, as a result, it is not precise and open to differences in interpretation. A good example is the definition of what is an Accord stream. It is defined as being a stride wide and a 'red band' deep or larger. Several measures to improve precision are recommended; these can be considered when the Accord is next reviewed by the Accord partners.
- Partly as a result of differing interpretations of the Accord, there are some differences in opinion about progress in meeting the Accord targets. It is recommended that changes be made now to a number of the annual survey questions to ensure a more consistent interpretation of the Accord targets.

These recommendations are detailed below.

4.2 Stock exclusion from streams

4.2.1 Measuring the input

The targets in the Accord relate to stock being excluded from Accord streams. All the RAPs acknowledge that steep banks can exclude stock, and that in these circumstances no fencing is needed.

Presently, the implementation of the fencing of Accord watercourses is measured by Fonterra through farmer self-reporting supported by some auditing. There are some problems with this as follows:

- exactly what constitutes an Accord stream is not defined with any precision
- there is no measure of how steep and/or high banks need to be to exclude stock
- there are no measures of the quality or permanence of the fencing necessary to exclude stock.

Definition of an Accord stream

While the definition of an Accord stream is presently very simple and easy to apply, it is imprecise and a value judgment is often required to determine what is, or is not, an Accord stream. This can potentially lead to different interpretations of progress towards the stock exclusion target.

Suggestions to improve on the existing definition were to specify a particular flow threshold, and to include all streams that were permanently flowing and shown on the NZMS M260 1:50,000 map series.

Although it was generally accepted that the definition needed to become more certain, all of the alternatives explored had benefits and drawbacks over the existing definition. There was little support for including a flow threshold.

The Accord will be reviewed by the Accord partners until 2007. Up until this time the various stream definitions should be compared against one another to determine their workability. This would be particularly relevant while undertaking any independent auditing.

Recommendation 1: That the formal definition of an Accord Stream be reviewed in light of the experiences gained in implementing the Accord in 2007.

Exclusion via steep or high banks

Some principles are needed to define in which circumstances steep banks exclude stock from streams. The suggestion made was this be in situations where the bank is so steep that a cattle beast would not normally walk down the bank of its own accord.

Recommendation 2: The definition of stock exclusion via high banks be:
'Where a cattle beast would not normally walk down of its own accord'.

Standards of fencing

Some interpretation of the type of fencing used to exclude stock from streams is needed. It was suggested this should refer to permanent fencing, as a survey carried out of farmers in the Toenepi catchment showed that many of the fences put up by farmers to keep stock out of streams were single wire and non-permanent.

A suggestion was made, and generally supported, that at some stage this question should be divided into two parts. The first would be 'do you have permanent fencing to exclude stock from an Accord stream?', and secondly, 'if not, are permanent posts in place to allow fencing (such as a hot wire) when stock are present?'

Recommendation 3: The question relating to stock exclusion be separated into two parts as follows:
(i) Over what lengths of Accord streams do you have permanent fencing to exclude stock?
(ii) Over what lengths of Accord streams do natural barriers exclude stock access?

Ideally, stream banks should be planted with native riparian species such as flax, sedges and rushes. While this is not an Accord target, it would be very useful to document the length of stream that has been fully planted and retired. This is because riparian vegetation provides substantially better in-stream habitat, and will help reduce sediment and nutrients entering water courses from overland flow. Farmers are presently asked a yes/no question as to whether any part of a stream has riparian planting.

Recommendation 4: A question be added to ask farmers:
'Over those sections of stream where stock are permanently excluded, what length has been retired and planted in riparian species?'

4.3 Regular crossings

4.3.1 Measuring the input

While it may appear relatively simple to measure whether a regular crossing is bridged or culverted, there is some debate about what constitutes a regular crossing. It was noted, for instance, that stock may be grazed in a paddock for a month or two each year, and that this may involve frequent stream crossings during this period, but that this would not qualify as a regular crossing using the current definition in the Accord.

Recommendation 5: In terms of the annual farm assessment questionnaire a 'regular crossing' be defined as:

- (i) where stock cross a permanently flowing stream at least twice a week during the milking season or
- (ii) where stock cross a permanently flowing stream at least 50 times in any given year.

4.4 Appropriate treatment and discharge of farm effluent

4.4.1 Measuring the input

The target in the Accord is that all farmers comply with their consent conditions all of the time. That target is certainly not being met at present, and is not being reported on nationally.

This target can be measured by annual reporting of the proportion of farmers that comply with their consent conditions. This can be expressed in simple terms, such as the percentages of Fonterra suppliers who comply fully with consent conditions (or permitted activity standards), those with minor or technical non-compliances and those with major non-compliances, and the number of enforcement actions taken against dairy farmers.

Recommendation 6: Reporting against the Accord target, that all farmers meet their resource consent requirements 100 percent of the time, be on the basis of regional authorities reporting annually the following information to the Ministry for the Environment:

Table 2: Recommended reporting format from monitoring of dairy effluent discharges

No. of Fonterra suppliers inspected	Percentage complying fully with consent or permitted activity requirements	Percentage with minor or technical non-compliances	Percentage with serious non-compliance (including those resulting from complaints)	No. of environmental infringement notices issued to suppliers	No. of prosecutions initiated against suppliers
		Defined as a non-compliance without any significant environmental consequences	Defined as a non-compliance that had significant adverse environmental effects		Separated into successful and unsuccessful prosecutions

4.5 Improved nutrient management

4.5.1 Measuring the input

This is the element of the Accord where least progress has been made to date, and where perhaps the greatest long-term benefits could potentially be made.

In carrying out the background research for this Strategy scientists and resource managers consistently said that dairy farmers typically over-fertilise, particularly with phosphate. Indeed, the plant available phosphate (Olsen P) is typically twice what it needs to be for optimum plant production on many dairy farms, and nitrogen levels are also often much higher than necessary. This has several undesirable environmental consequences:

- Phosphate is highly mobile, and when applied over and above what is necessary for plant growth, will eventually enter water courses. As most New Zealand rivers and streams are phosphate-limited, this run-off will result in the elevated growth of macrophytes and algal communities. This reduces the suitability of the water for contact recreation, reduces habitat quality and can result in low nocturnal dissolved oxygen levels due to plant respiration.
- Nitrogen similarly enters streams, and will promote algal and macrophyte growth where the watercourse is nitrate-limited. Most estuaries are believed to be nitrate-limited, so nitrate discharges will accelerate the eutrophication of many estuaries. Elevated nitrate levels in run-off from land use, if not controlled, is predicted to reduce the clarity of Lake Taupo by over a third in the next 20 years.⁴
- Many lowland lakes are already eutrophic, and ongoing nutrient run-off accelerates this eutrophication. A particularly notable example is Lake Ellesmere (Te Waihora) in Canterbury.
- Nitrate-nitrogen contamination of shallow groundwater is an issue of major concern in some regions. In Canterbury, for example, it is considered the single most adverse effect of intensifying land use. Improved nutrient management on farms should lead to reduced nitrate leaching to groundwater.

⁴ It is instructive in this case to note this is not due to dairying, which presently covers less than 0.5 percent of the Taupo catchment. Rather, the increasing nitrogen levels entering the lake reflect general intensification of catchment land uses, including forestry and drystock farming. Too often, dairying is portrayed as the 'bad guy' causing declines in surface water quality, but this is not necessarily the case.

Much has been published recently by researchers looking at nutrient management on farms, and how off-site effects can be minimised. If most dairy farmers can get the message that fertiliser applications are generally too high, and that reducing these will lead to both cost savings and environmental benefits, the potential environmental gains would be very significant.

The present measure of this input refers to nutrient budgeting. This measure would be much more meaningful if it referred to active nutrient management with the goal of minimising nitrogen and phosphate leaching and run-off to surface water or groundwater. Preparing a nutrient budget achieves little unless it is accurate and fully implemented.

Recommendation 7: The questions to be asked about the nutrient budgeting target be phrased as follows:

- (i) Do you have a nutrient budget for your dairy farm?
- (ii) If so, who prepared that nutrient budget?
- (iii) Do you use the nutrient budget to actively manage nutrient levels and fertiliser inputs on your dairy farm?

4.6 Fencing out of wetlands

4.6.1 Measuring the input

This is a reasonably straightforward element of the Accord to monitor progress against. There are some issues about what does or does not constitute a wetland under the Resource Management Act, but this can be resolved by councils on a case by case basis.

Measuring progress relies on regional (or perhaps territorial) authorities having inventories of the regionally significant wetlands either now, or in the near future. Interviews with councils indicated that this was generally the case. Exceptions included Canterbury, Marlborough and Tasman (where those interviewed reported there were few wetlands on dairy farms in any case).

The measure needs to include a description of the quality of the fencing. This could be, for instance, 'permanent fences at least one metre high and comprising at least two wire strands set back at least five metres from the boundary of the permanently wet area in the wetland'. It is more appropriate, however, that this be determined by each council on a case by case basis.

It is much more difficult to provide any generic suggestion as to how to protect the natural water regime of a significant wetland. In some instances, such as Lake Wairarapa, it simply cannot be protected. It is suggested this also be left to councils to address on a case by case basis.

The delivery of this target would be best measured by councils, as they will generally be monitoring the regionally significant wetlands for other biodiversity-related purposes.

Recommendation 8: In relation to the fencing out of significant wetlands and protection of their natural water regimes:

- (i) The standard of fencing necessary be determined on a case by case basis by the regional authority.
- (ii) The level of protection of the natural water regime that is necessary to protect the wetland also be determined on a case by case basis by the regional authority.
- (iii) Monitoring and reporting of implementation be carried out by regional authorities and forwarded annually to the Ministry for the Environment.

5 Measuring the Environmental Outcomes of Implementing the Accord

This chapter presents an outline of how the environmental outcomes of implementing the Accord may best be monitored. Section 5.1 reviews the challenges of trying to quantify any broad scale environmental benefits that result from actions taken under the Accord. Section 5.2 establishes a set of criteria for assessing any monitoring components. Section 5.3 sets out the recommended elements of a strategy to determine the environmental outcomes of implementing the Clean Streams Accord.

5.1 The challenges

There are some significant challenges in preparing a monitoring and reporting strategy to measure the environmental outcomes of implementing the Accord. Perhaps the greatest single challenge is how to separate out the benefits of the often relatively minor on-farm management practice changes resulting from the Accord (in an overall catchment context) from all the other activities occurring in a particular catchment. There are many factors that can affect water quality in a catchment, and entirely separating out the effects of implementing the Accord from this ‘background noise’ is not possible using the general state of the environment (SoE) monitoring data currently collected by all councils. As a consequence, a more targeted programme is recommended that builds on the existing SoE monitoring where possible, and that will provide sufficient information to enable a broad picture of what environmental benefits the Accord is having.

There are many factors that contribute to the background ‘noise’ in a catchment including:

- (a) naturally occurring events such as floods, which can have major effects on suspended sediment, turbidity and in-stream biota
- (b) changes in farm personnel, such as the sharemilker, with subsequent changes in environmental performance
- (c) changes in land use or land-use intensity, such as changing from sheep to deer farming, bringing more beef cattle on to a particular property, or increasing dairy herd size
- (d) the amount of fertiliser used by all farmers, and the timing of its use and how it is applied. Aerial topdressing of hill country may, for instance, have significant impacts on phosphate levels and algal biomass in streams. Similarly, if there is heavy rainfall within several days of fertiliser application, much of that fertiliser may run off to water
- (e) stock access to streams, not just by dairy cattle on smaller streams but also beef cattle and deer
- (f) fences that are too close to streams, or which are broken or poorly maintained and allow stock access to streams
- (g) discharges to water, including those of dairy effluent

- (h) wintering dairy stock off-site – this has potential major benefits for water quality during these months
- (i) run-off from land irrigation of dairy effluent entering watercourses from mole or tile drains, or from the mechanical failure of irrigation equipment
- (j) factors such as changing a farm dairy discharge from water to land.

There are also many regulatory interventions that may have significant impacts. These could be as simple as requiring a farmer with poor environmental compliance with effluent discharge consent conditions to improve that performance, with consequential benefits for water quality. Most regional authorities also encourage all farmers to fence out streams, retire and plant stream margins, and improve management of discharges of dairy effluent to land. Such factors further confound the separation of the effects of implementing the Accord from all else that goes on in a catchment.

Many streams in dairy catchments have soft bottoms, which typically do not support diverse stream invertebrate communities. This is an issue because measuring the ‘health’ of stream communities, through indices such as MCI or QMCI, is an excellent way of measuring any improvement attributable to improved management practices such as implementing the Accord (although such soft-bottomed stream indices are being developed).

Other streams in dairy catchments have high levels of silt covering stony-bottomed beds. A very good example is the Waikakahi Stream in South Canterbury, which is one of the four best practice dairy catchments. This silt, which is likely attributable to stock having access to streams, also affects the ‘health’ of stream communities and can limit their value for trout spawning. Once in a stream, silt is only likely to be removed during large floods.

Another possible confounding factor is the ‘lag time’ between an action being taken, and the effects of taking this action. The exact nature of this lag time is not well known, but it is accepted that applying nutrients to land, for instance, does not have an immediate effect on water quality (unless the nutrients directly enter water) and that the lag time before changes are seen in surface water quality can span several years. Any monitoring programme needs to be long term, and it may be that clear results are not evident for some time.

5.2 Proposed assessment criteria

Prior to considering and recommending an appropriate national monitoring strategy for the environmental outcomes of the Accord, it is necessary to develop a set of criteria against which potential programme elements could be critically assessed. These criteria form the ‘critical success factors’ that the programme must achieve in order for it to be justifiable and robust. The assessment criteria are aimed at the catchment level and are as follows.

5.2.1 Nature of the catchment

Ideally any monitoring should be undertaken in catchments which are very largely used for dairying, or where dairying occurs in a largely discrete part of the catchment. In either case, monitoring of water quality and biota at one or more control sites upstream of the influence of dairying, and other sites downstream of a cluster of dairy farms, will allow the effects of dairying to be reasonably well separated from the effects of other farming activities in the catchment.

An ideal catchment would be one where the land use upstream of dairying is either native bush, or extensive traditional dry-land pastoral farming. Streams that drain from native forest (e.g. from the Ruahine or Taranaki Ranges or Mt Taranaki), or spring-fed streams, are ideal examples.

There should be no major point source discharges to the catchment upstream of the lowest monitoring point, apart from on-farm dairy effluent discharges. Ideally, there will be little summer water abstraction for consumptive use.

Catchments monitored should ideally be smaller in size, of say 5 to 50 km², as these are likely to provide situations where the influence of other factors that may confound the interpretation of the monitoring will be fewer and more easily isolated.

The catchments selected should be spread geographically across the country and represent a range of stream types. The River Classification Database (REC) should be used to type any selected catchments.

5.2.2 Implementation of the Accord

Ideally implementation of the three parts of the Accord relevant to water quality (stock exclusion from streams and their banks, bridging or culverting of regular crossings, and nutrient budgeting) would initially be little progressed in the catchments selected for intensive monitoring. This may seem counter-intuitive, but it would allow for baseline or control data to be obtained against which any changes resulting from the Accord’s on-farm management practices could be assessed.

Alternatively (and perhaps more likely), a control site should be available upstream of the dairy farm properties to enable ‘control’ water and habitat quality data to be obtained. In these situations, however, only the impact of on-farm changes undertaken after the initiation of downstream water quality data collection will be able to be assessed.

5.2.3 Existing water and habitat quality

The more degraded the existing water and habitat quality is downstream of the dairying properties, the easier it would be to separate the benefits of implementing the Accord through measurable improvements in water quality. As noted above, however, high levels of silt covering stony-bottomed beds of creeks will reduce measures of stream health, and will only be removed during floods.

Alternatively, where the background water quality above the farms is high, one might expect downstream water and habitat quality degradation to be evident. This would provide evidence of the adverse effects of dairying activity and the nature and scale of that degradation. Any improvement resulting from implementation of the Accord could then be assessed.

5.2.4 Knowledge of land use

One of the major difficulties in implementing this strategy is that the findings will only be as good as the information available about **all** land-use changes in a catchment above the downstream monitoring site. It will be necessary to understand many of the environmental factors listed in section 5.1 above, if there is to be any realistic prospect of linking cause (implementation of the Accord) to effect (any environmental outcome). This reinforces that small-scale catchment monitoring programmes focusing on discrete blocks of dairy farms are likely to be much more useful than general catchment-wide monitoring.

5.2.5 Existing water quality data

Ideally, there would be some information gathered over at least five to 10 years and at least at a bi-monthly frequency to determine existing water quality in the catchment. Ideally also, some biological monitoring of algal and macroinvertebrate populations will have been carried out. This could have been carried out as part of a SoE programme, or undertaken as part of more specific investigations.⁵

Although a lack of existing background information may indicate a particular catchment would not be suitable for inclusion in this strategy, it should not be dismissed for this reason. Given this is a long-term strategy, there is time to collect that background information in emerging dairy areas likely to be subject to future land-use changes (dairy conversions), but ideally there will be good baseline material available to start with.

Similarly, there is also time to collect information in catchments which are presently in intensive dairying but where the implementation of Accord targets has made little progress.

In terms of what needs to be monitored in rivers and streams, any programme should ideally include the following range of parameters:

⁵ In general terms most SoE programmes are either insufficiently intensive (e.g. there might be one site in a medium-sized catchment versus the three to four that may be required to show any benefits of implementing the Accord), and/or have only been initiated in the last few years, and/or sampled too infrequently to show anything other than broad trends.

Table 3: Suggested in-stream monitoring parameters

Parameter	What it can measure	Confounding factors/comment
Faecal coliform bacteria (preferably <i>E. coli</i>)	Stock access to watercourses Diffuse run-off	Stock access to smaller non-Accord watercourses; other stock in streams; dairy effluent entering streams via mole or tile drains, irrigators or direct discharges. Non-stock sources such as vegetation decay or urban run-off.
Suspended solids and turbidity	Stock access to watercourses Diffuse run-off	High flows; stock access to smaller watercourses; other stock in streams, other land uses (cultivation, forestry).
Nutrient levels (typically nitrate nitrogen, total nitrogen, total phosphate, dissolved reactive phosphate)	Effectiveness of nutrient management; direct access to watercourses, diffuse run-off	Stock access to smaller watercourses; other stock in streams; dairy effluent entering streams via tile drains, irrigators or direct discharges; use of fertilisers by other farmers.
Conductivity (measures total dissolved soluble salts)	Coarse but useful measure of nutrient levels	Stock access to smaller watercourses; other stock in streams; dairy effluent entering streams via tile drains, irrigators or direct discharges.
Ammoniacal nitrogen	Generally direct discharge of dairy effluent to streams. Will assist in determining the effectiveness and compliance with discharge to land permits.	Few other confounding factors. Is toxic to fish at elevated concentrations. Usually from point source discharges.
BOD ₅	Generally direct discharge of dairy effluent to streams. Will assist in determining the effectiveness and compliance with discharge to land permits.	If elevated can generally be attributed to point source discharges, or to direct entry to water of effluent disposed to land.
Algal biomass	Effectiveness of nutrient management	Other nutrient inputs, freshes scour algae from stones and much reduce biomass.
Stream macroinvertebrates	General stream health and condition, e.g. MCI, QMCI. Will be affected by direct access to streams, poor management of discharges.	May not be sufficiently accurate to measure any changes. Affected by factors such as flooding, water temperature, stream bedload transport, siltation, point source discharges, and water abstraction.
Stream flow	Natural hydrological flow regime of a catchment.	Required to interpret natural perturbations and influences on any information collected.

5.2.6 Intensive or extensive monitoring, or both

One of the matters that needs careful consideration is whether monitoring should be carried out extensively over an entire year, intensively over a shorter timeframe (which would be repeated in selected years), or a combination of these approaches. An associated issue is whether intensive monitoring needs to be carried out every year.

Monitoring of water quality is most likely to show improvements due to implementation of the Accord over the drier summer and autumn months when stream flows are generally low. This is because there will be less direct contamination of small and ephemeral watercourses and less risk of effluent discharge run-off directly to water (as might occur due to entry via mole or tile drains, or by overland flow when soil moisture levels are high). The results will also not be confounded by stock being wintered off-site.

Biological monitoring is best carried out during summer months when larger instars of insects are present, allowing for more straightforward identification.

Intensive monitoring has the advantage that the effects of some of the possible confounding factors listed in section 5.1 above can be more readily identified, and so aberrant results can be more readily attributed to a distinct cause.

The difficulty with intensive monitoring in isolation is that it may be too infrequent to readily show statistically valid, long-term trends. Ideally, a mix of extensive, monthly water quality sampling of basic parameters, along with more intensive monitoring during a relatively short period over summer, is preferred. In saying this, it is recognised many councils could find it difficult to fit such work in over the busy summer period.

The extensive monitoring should be sufficient to show any long-term trends. Biological monitoring need only be undertaken during the summer period.

Furthermore, it is not necessary to carry out intensive monitoring over each and every summer. Once intensive sampling has been carried out to establish 'baseline' condition, further intensive sampling need only be carried out once every three to five years, with more extensive monitoring in between times. This will be quite adequate to show long-term trends.

This is discussed further in section 6.2 below.

5.2.7 Monitoring of groundwater?

At this stage there is no recommended additional systematic monitoring of groundwater quality as part of assessing the benefits of implementing the Accord. This is because the Accord's primary focus is on minimising the impacts on surface waterbodies. The main contaminant in groundwater resulting from intensive land use is nitrate-nitrogen, with some associated faecal coliform contamination of very shallow groundwater. While nutrient management may help reduce nitrate levels in soils, it is phosphate that is 'overfertilised' to the greatest extent on dairy farms.

Groundwater monitoring could be included if the targets of the Accord were to change. Two practices that would significantly reduce nitrate-nitrogen leaching to groundwater are wintering of dairy stock off-site, and the use of nitrification inhibitors. If it is proposed that these, or similar, practices be added to Accord targets sometime in the future, then additional groundwater monitoring should be carried out.

There are some existing studies looking at the impacts of dairying on groundwater, including two very comprehensive compliance programmes in Hawke's Bay. These could be used as case studies that supplement the work proposed in the Tier 2 catchments below.

5.2.8 Timeframe

Any national monitoring strategy must by definition be long term, given the significant lag times that can arise between land-use changes (including the Accord on-farm management practices) and subsequent effects on water quality.

As a minimum, the programme needs to run for at least 10 years, and preferably 15 years. It is also likely that it will take at least five years for any definitive results to be gathered. Accordingly, reporting is recommended at five-yearly intervals.

Within the timeframes recommended it is likely that Accord targets will change, with perhaps additional targets added. This will not affect the robustness of the proposed programme, and, depending on the nature of the targets adopted, may assist to show the environmental benefits of implementing the Accord.

5.2.9 Provision of supporting information

Any monitoring programme will require at least four separate sets of information to determine existing condition for the catchments as follows:

- detailed information about dairying land use in the catchment⁶
- information about other land uses in the catchment
- a robust assessment of progress towards Accord targets
- an assessment of existing water quality information in the catchment.

Responsibilities for how this information will be collected and/or made available are set out in section 6.

5.2.10 Will monitoring change behaviour?

One factor that cannot be removed from any recommended monitoring programme is the extent to which farmers in catchments that are being monitored, or on farms where more intensive monitoring programmes will take place, will change their behaviour and improve their environmental performance such that they behave better than the 'average farmer'.⁷ For instance, in the four best practice catchments farmers are being strongly encouraged to undertake on-farm management practice improvements. This may bias the results from the monitored catchments, which could be problematic if those results are scaled up to provide national-level information.

⁶ It would be desirable to understand the history of dairying in the catchment in at least broad terms. This is because there is often a lag time between land-use changes and the impacts being observed in watercourses.

⁷ By, for instance, constructing more secure fences preventing stock entering waterways, or by undertaking more robust nutrient management.

There is no easy way around this potential problem. Only ‘samples’ can be taken in a programme like this, and there is no way of knowing if those samples are atypical. If, however, the monitored catchments do show improvements, this can be safely extrapolated to say that other catchments where progress has been made towards implementing Accord targets will also show improvements in environmental and habitat quality. This is the stated target of implementing the Accord.⁸

5.3 National and regional data sets

It is clear from the discussion above that neither national nor regional data sets derived from existing national (or aggregated regional) SoE programmes can be used with any reliability to measure the benefits of implementing the Accord. There are too many confounding factors, and the monitoring at such a broad level spatially, to expect any benefits of the relatively minor and highly localised land-use interventions occasioned by the Accord to be detectable in national or regional water quality data sets.

Indeed, it is considered inappropriate to make any such links given the impacts of all possible land-use changes, the potential effects of point source or unauthorised discharges, activities such as water abstraction, and natural perturbations such as floods and droughts, on water quality and biota.

However, such data sets will be useful in providing the overall broad-scale environmental trends against which Accord-specific data can be assessed.

5.4 Catchment data sets

The best chance of monitoring the environmental outcomes of implementing the Accord is using a three-pronged approach in:

- the best practice dairy catchments
- the Tier 2 catchments
- site-specific studies.

These are described in turn.

⁸ An MSc study just initiated by Gymn Morgan of the ARC looks at the attitudes of farmers to the Accord. The information gathered in that study may help better understand this question. What has been very clear to us in talking to regional authority staff is that the Accord has had a very positive effect on the attitude of dairy farmers to the environment.

5.4.1 The best practice dairy catchments

The first element of this approach is continuing work in the four intensively-studied best practice dairy catchments, namely:

- (a) the Toenepi catchment in the Waikato
- (b) the Waiokura catchment in Taranaki
- (c) the Waikakahi catchment in the Waitaki Basin
- (d) the Bog Burn catchment in Southland.

Each of these catchments is discussed in Appendix 3.⁹ In doing so, however, it is noted that there are two significant hindrances to using these catchments to monitor the benefits of implementing the Accord:

1. Strong effort has already gone into improving dairy practice in these four catchments. This means, for instance, that farmers have already been encouraged by scientists working there to fence out streams, manage nutrient levels and the like. In other words many of the elements of the Accord have already been undertaken in these catchments. This, along with the other best practice initiatives, will make it difficult to separate out the benefits of implementing the Accord in its own right.
2. Of the four catchments, only the Tonepi and Bog Burn are considered ‘typical’ dairying catchments by the relevant regional authority. The Waiokura is regarded as quite atypical by the Taranaki Regional Council in that it rises on the upper slopes of the ring plain, rather than on the higher slopes of Mount Taranaki as most streams in that region do. The Waikakahi is not typical of Canterbury streams as it is irrigated, with average summer flows being nearly an order of magnitude higher than winter flows.

Recommendation 9: In the existing four best practice dairy catchments the existing information be assessed to determine its ability to ‘explain’ the benefits of implementing the Accord and, subject to ongoing funding, agree a programme to attempt to isolate the benefits of implementing the Accord from the other interventions already being implemented to improve dairy practice.

⁹ Another intensive catchment study has started recently at Inchbonnie in the Lake Brunner catchment on the West Coast. We do not consider that catchment here as it is outside of the regions where Fonterra operates.

5.4.2 The Tier Two catchments

The second element of monitoring the environmental outcomes of implementing the Accord is to initiate (or continue) intensive monitoring in a further eight or so representative small catchments around the country which broadly meet the assessment criteria outlined in section 5.2 above. These are referred to as the 'Tier 2' catchments. Information will also be needed about land use and land-use change in these contributing catchments. Assessing the impacts of land-use interventions at a small scale will allow the effects of those changes to be determined in a semi-quantitative manner. For example, over time it may be possible to quantify the improvements to water quality achieved by fencing out all Accord streams on small groups of dairy farms.¹⁰ This level of benefit could then be scaled up to derive regional or national benefits that might be achieved if all farms complied with the Accord targets.

The catchments which we propose be included in this programme based on discussions from regional authorities, are as follows.

Recommendation 10: The following catchments make up the 'Tier 2' catchments in which the benefits of implementing the Accord will be monitored in depth.

- (i) A selected catchment in the Northland region.
- (ii) The Taharua catchment in the Rangitikei Catchment in western Hawke's Bay.
- (iii) The Mangapapa Catchment near Woodville in the Manawatu Catchment.
- (iv) The Enaki Catchment, a tributary of the Mangaterere River in the Wairarapa.
- (v) The Motupipi Catchment in Golden Bay.
- (vi) The Rai River (or alternatively the Tuamarina River) in Marlborough (but only to monitor the impacts of improving stream crossings).
- (vii) The Rhodes Stream catchment in South Canterbury.
- (viii) The Washpool catchment, a tributary of the Pomahaka River in southwest Otago.

5.4.3 Site-specific studies

The third element of the recommended strategy is to carry out site-specific studies on the environmental outcomes of implementing one or more aspects of the Accord on a few properties, or even one property. This could be, for instance, by pre and post monitoring once one or more crossings are put in, and some fencing carried out. Ideally, such farms would be the catchment's most upstream dairy farms with native bush headwaters.¹¹ No specific recommendations are presented at this time, but future studies may be needed.

¹⁰ Obtaining similar data sets from several different councils would enable different land forms, climatic conditions and stream types to be accounted for in a very rough order manner.

¹¹ In saying this we are aware that some such studies already exist. We have not reviewed these at this time.

6 Establishing the Tier 2 Catchments

6.1 Establishing the base condition

6.1.1 Information about farming practice

The first step in establishing any new monitoring catchment will be to collect some basic information on the nature of the dairying in the catchment. This would need to include:

- the number of dairy farms present, herd sizes and stocking rates (and ideally some information about the recent history of dairying in the catchment)
- some information about other land uses in the catchment that may affect water quality
- the percentage of stock wintered off each property
- how dairy effluent is disposed from each property, and how well the conditions of consent are presently complied with
- whether there are any particular issues or problems to resolve, for example, the presence of mole and tile drains.

6.1.2 Information about progress towards Accord targets

Robust information needs to be collected about progress towards Accord targets including:

- agreement about which watercourses are Accord streams
- to what extent stock are excluded from those streams – what proportion is fenced out, how good is that fencing and is it accompanied by riparian zone retirement
- how many regular stream crossings are present, and of those, which ones are bridged or culverted
- how many of the farmers are carrying out nutrient budgeting, and are any undertaking active nutrient management
- are there other activities carried out by farmers that will have potential benefits for stream water quality and stream health. An example would be the use of low-pressure irrigation systems.

6.1.3 Environmental information

Regional authorities will be able to collate existing environmental information about the catchment:

- is there any flow recording site in the catchment, or if not, is flow information available from a nearby similar catchment from which some correlation could be made?
- what water quality data are available? For how long and from which sites? Has that data been analysed for any purpose?
- has a riparian habitat condition survey been carried out?
- have any analyses of stream sediment been carried out?
- has any biological information been collected, such as on-stream algal biomass, stream macroinvertebrates or fish communities (from the NIWA freshwater fish database)?¹²

Some councils have already collated this type of information. An example of the type of information available is presented in Appendix 4 of this report.

Recommendation 11: In each of the above catchments:

- (i) baseline information about dairying land use be collected by Fonterra
- (ii) accurate information about progress towards Accord targets be collated by Fonterra
- (iii) existing environmental information, such as that on flows, water quality and aquatic ecology, be collated by the regional authority.

6.2 The monitoring programme

The next step is to establish the monitoring programme in the study catchment. This again involves three elements:

- ongoing monitoring of dairy practice in the catchment
- ongoing monitoring of progress towards Accord targets
- water quality and biological monitoring of streams (and possible flow recording).

The latter element is the major component of this programme. Each catchment will need at least two sites established, one upstream of the influence of dairying and the other downstream of at least some dairy properties. In reality, each catchment will likely need three to four sampling sites established.

Intensive monitoring will be necessary to establish the base condition of the catchment, and will need to be repeated once every three or four years. In between times, more extensive monitoring can be carried out to monitor trends.

¹² It may also be possible to use the REC classification to determine the biota that might be expected to live in the watercourse being studied in natural conditions.

Water quality at each site should be monitored for the following parameters: suspended solids, turbidity, volatile suspended solids, conductivity, total phosphate, dissolved reactive phosphate, total nitrogen, nitrate + nitrite nitrogen, ammonia nitrogen, dissolved oxygen and *E. coli*.

- Subject to the physical logistics of carrying out the monitoring, the frequency of water quality sampling should be increased during summer (January to March inclusive) as this is the time that the greatest benefits from the Accord actions are likely to occur.
- Biological monitoring of macroinvertebrates and algal biomass should be undertaken in January or February.
- Ideally, flow-monitoring information should be available at the monitoring site located at the downstream end of the monitoring reach. This will enable water quality to be correlated with stream flows.

Recommendation 12: In each of the above catchments:

- Ongoing information about dairying land use in the catchment be collected by Fonterra.
- Accurate information about progress towards Accord targets be collated annually by Fonterra.
- Water quality and biological monitoring be carried out by the regional authority.

Recommendation 13: As a minimum the monitoring programme established in each catchment:

- Comprise at least three sites, one as a control upstream of any influence of dairying.
- Water quality at each site be monitored monthly for the following parameters: suspended solids, turbidity, volatile suspended solids, conductivity, total phosphate, dissolved reactive phosphate, total nitrogen, nitrate + nitrite nitrogen, ammonia nitrogen, dissolved oxygen and *E. coli*.
- The frequency of water quality sampling be increased during summer (January to March inclusive) as this is the time that the greatest benefits from the Accord actions are likely to be recorded.
- Biological monitoring of macroinvertebrates and algal biomass be undertaken in January or February.
- Intensive monitoring take place for one year to establish base condition, then more extensive monitoring be undertaken for two to three years after which the intensive programme be repeated. This is shown in the following table:

Table 4: Suggested in-stream monitoring regime

Year	Nature of monitoring	Comment
1	Intensive physico-chemical and biological monitoring over summer (January to March); monthly physico-chemical monitoring in other months.	Purpose is to establish baseline condition.
2	Monthly physico-chemical sampling in summer; every two months otherwise.	More intensive sampling may be necessary if any unusual results are recorded.
3	Monthly physico-chemical sampling in summer; every two months otherwise.	More intensive sampling may be necessary if any unusual results are recorded.
4	Either repeat year 1 or continue year two and three programme.	Purpose of repeating year 1 is to establish extent of change.
5	Repeat year 1 (if not done in year 4) or continue year 2 and 3 programme.	

Recommendation 14: The detail of the monitoring programme to be carried out in each of the catchments listed in recommendation 11 be agreed between Fonterra and the relevant regional authority, and included as an Appendix to the Regional Action Plan.

6.3 Other monitoring

A number of other studies being undertaken around the country can also be incorporated into this monitoring and reporting strategy to further assess the impacts of dairying on the environment. These include:

- Monitoring of shallow groundwater up gradient and down gradient of two intensive dairy farms in Hawke's Bay. One farm is located over the Ruataniwha unconfined aquifer and the other is located on a perched aquifer adjacent to the upper reaches of the Ngaruroro River. On this later farm, AgResearch have undertaken a two year investigation (at the landowner's cost) using ceramic cup sampling of drainage water to try and differentiate the impacts of dairy-cow grazing (dung and urine patches) from effluent irrigation to land.
- The Lake Rerewhakaaitu Catchment in Bay of Plenty is being studied using money from the Sustainable Farming Fund (SFF) administered by the Ministry of Agriculture and Forestry. The work is being undertaken because the community is concerned about the impact of farm management practices on water quality in the lake. The work is being undertaken by AgResearch and NIWA in conjunction with Environment Bay of Plenty (EBoP).

The catchment is predominantly in dairy pasture, with about 30 farms present. This is unique among the Rotorua lakes. There is concern that the movement of dairy farm effluent through soil water to the lake will result in enrichment. EBoP have already found increasing nutrient level in inflows to the lake. Currently the lake meets the Trophic Level Index set by EBoP in their Regional Water and Land Plan. However, with the trend in dairy farming for intensification, to maintain the health of the lake practical methods are needed for farmers to minimise impacts on the lake, while allowing them to operate sustainable farm businesses. It is anticipated that the results from this study will be able to be transferred to other lake catchments.

7 Reporting

As discussed earlier, it will be possible to compile a national overview of the environmental effects of the Accord by collating the data available from the four best practice dairy catchments and the additional recommended eight or so regional catchments. This will be carried out by MfE on a five-yearly basis.

A reporting format needs to include the following matters:

7.1 Reporting progress towards Accord targets

It will be necessary to continue and enhance regular reporting of progress towards Accord targets, and to report the environmental outcomes of implementing the Accord. It is suggested this be as follows:

- Fonterra report annually on farmer surveys and any independent auditing showing progress towards meeting Accord targets.
- MfE collate data annually from regional authorities on compliance with resource consents by Fonterra suppliers. This should be published at the same time as the Fonterra report, which will be in October or November each year.
- Regional authorities summarise information from the Tier 2 catchments, and Fonterra summarise work in the four best practice dairy catchments, once every five years starting early 2012. These reports will focus on the environmental outcomes of implementing the Accord.
- MfE compile a national overview of progress towards Accord targets annually starting June 2007. Every five years this report will be much expanded as it will also report on progress towards environmental outcomes.

7.2 Regional progress towards environmental outcomes

Regional reports on progress towards meeting environmental outcomes should follow a consistent format to allow ready compilation of information. This should include:

- a description of the catchment being monitored
- land use in the catchment, and any changes in land use in previous years
- summary of progress towards Accord targets
- flow records (if available)
- summary of water quality sampling results
- summary of biological monitoring results
- trend analysis (if appropriate)
- discussion – emphasising any links between implementation of the Accord and environmental outcomes.

Such a report should be prepared for each of the Tier 2 catchments every five years starting early 2012.

7.3 National progress towards environmental outcomes

The information collected by Fonterra and the regional authorities on environmental outcomes could be collated in a number of ways. It is beyond the scope of this report to do this, but there are two matters to which careful attention will need to be paid:

- given that the dataset is relatively small with diverse catchments of different sizes and characteristics, much caution is needed if using aggregated information to show any nationwide trends
- it is doubtful it will be possible to show any statistically significant changes from the Tier 2 catchments. If statistical validity is desired, then studies should be designed to show the benefits of, say, excluding stock or bridging a heavily used crossing.

Some overview could, however, be provided in several ways, such as presenting aggregated information on the water quality upstream and downstream of the dairy farms together with any changes in that water quality over time, as Accord actions are implemented. It may be possible to isolate specific actions (such as fencing or culverting) in the time series of data and attribute water quality improvements to those practices.

It may then be possible to undertake very broad-scale ‘predictions’ of national benefits. If, for example, the study catchments showed that fencing of all Accord streams on dairy farms resulted in (say) a 20 percent reduction in annual nutrient mass loads to the monitored streams then predictions could be made of the national level benefits that might result if all dairy farms undertook similar actions. This could be done by calculating average nutrient outputs per hectare¹³ for farms without streamside fencing and multiplying that value by the area of dairy farms nationally, and comparing that to the value assuming all farms implemented stream-side fencing.

Such predictions should be limited to a few key parameters such as nitrate nitrogen, total phosphorous and total suspended sediments. It would be meaningless to predict mass loads for faecal bacteria, but it may be possible to use alternative indicators such the number of occasions per annum that contact recreation standards were breached up stream and downstream of the monitored farms based on monthly sampling frequencies.

Similar ‘predictions’ of the rough order scale of national environmental benefits could then be made for each of the Accord actions. These ‘predictions’ could be updated overtime as additional information was gathered by the regional catchment studies and also as the area of land under dairying changed each year.

¹³ This information is available from literature and New Zealand catchment studies including those referred to in this report.

It may prove difficult to separate out the impacts of individual Accord actions (e.g. stock exclusion as opposed to culverting or nutrient budgeting). In that case it would still be useful to report on the predicted cumulative benefits of the Accord actions taken as whole.

Although there are strong limitations to such an aggregating and predictive approach, some form of national collation or overview is necessary if this strategy is to have any real value. Otherwise MfE will be left with a series of discrete monitoring results from eight or so catchments with no view on the collective environmental benefit of the Accord nationally.

8 A Proposed Monitoring and Reporting Strategy

In summary, the proposed monitoring and reporting strategy contains five elements:

1. Better definition of the Accord targets and how these are monitored and reported.
2. Ongoing monitoring in the four best practice dairy catchments, with some modifications to monitoring to try and separate out the benefits of implementing the Accord for these watercourses.
3. Adding about eight other representative catchments around the country to the monitoring network to specifically assess the benefits of implementing the Accord. Preliminary suggestions are made as to what these catchments could be. The detail of the monitoring programmes should be provided through the Regional Action Plans.
4. Some site-specific studies to assess the benefits of Accord interventions.
5. Cautious national aggregation of the predicted environmental benefits of the individual Accord actions or the cumulative benefits of the Accord in total.

9 Suggestions for Future Best Practice

The research undertaken for this strategy involved some discussion of possible best practice in dairying. Some of these discussions indicated where the industry could take further initiatives to improve the environmental outcomes from dairying. Some of these initiatives have already been undertaken in the four best practice catchments, and they show where the industry could take further initiatives to minimise the effects of dairying on the environment.

These practices are documented particularly by Mongahan et al (2003) and Mongahan et al (2004). In no particular order, these include the following practices:

- The possible use of low pressure irrigation systems, such as K-Line irrigation, for the disposal of dairy effluent to land. This has the major advantage over current systems, such as the use of travelling irrigators, that the effluent is spread over a much more limited area, and that the chances of mechanical failure are far lower. This means, for instance, that there is much less chance of ponding, or of effluent inadvertently running off to surface water. It is a particular advantage in country with mole and tile drains present; research in progress shows that it can reduce direct transfer of phosphate and microbial contaminants in mole drains in the Bog Burn catchment by up to 90–95 percent.
- The use of nitrification inhibitors, such as Eco-N,¹⁴ to reduce nitrate run-off to streams and to shallow groundwater, with adverse effects on the quality of that water for domestic supply. Work undertaken at Lincoln University shows these can have very strong benefits, including reducing leaching losses and improving soil nitrate nutrient retention. This results in less need for nitrogen fertiliser to be used, with significant economic gains for farmers.
- Reducing levels of plant available phosphate in soils would have significant benefits for stream water quality and habitat quality.
- Wintering stock on feed pads to reduce nitrogen excretion to pasture.
- Reducing irrigation by-wash from border-dyke irrigation systems, as this run-off typically contains elevated levels of nutrients and microbial contaminants.
- Applying phosphate fertiliser at times when irrigation is not taking place.

Recommendation 15: Fonterra consider how the best management practices listed in section 9 of this report be included in any future revision of the Dairying and Clean Streams Accord.

¹⁴ Eco-N is a Ravensdown product. It is a nitrification inhibitor which reduces the activity of nitrosomonas bacteria in the soil and this reduces the rate of conversion of ammonium to nitrate. Ammonium is not as prone to leaching as nitrate and therefore there is less risk of nitrogen 'leaking out' of the plant root zone.

10 Recommendations

Recommendation 1: That the formal definition of an Accord Stream be reviewed in light of the experiences gained in implementing the Accord in 2007.

Recommendation 2: The definition of stock exclusion via high banks be ‘where a cattle beast would not normally walk down of its own accord’.

Recommendation 3: The question relating to stock exclusion by fencing be separated into two parts as follows:

- (i) Over what lengths of Accord streams do you have permanent fencing to exclude stock?
- (ii) Over what lengths of Accord streams do natural barriers exclude stock access?

Recommendation 4: A question be added to ask farmers ‘over those sections of stream where stock are permanently excluded what length has been retired and planted in riparian species?’

Recommendation 5: In terms of the annual farm assessment questionnaire a ‘regular crossing’ be defined as:

- (i) where stock cross a permanently flowing stream at least twice a week during the milking season or
- (ii) where stock cross a permanently flowing stream at least 50 times in any given year.

Recommendation 6: Reporting against the Accord target that all farmers meet their resource consent requirements 100 percent of the time be on the basis of regional authorities reporting annually the following information to the Ministry for the Environment.

No. of Fonterra suppliers inspected	Percentage complying fully with consent or permitted activity requirements	Percentage with minor or technical non-compliances	Percentage with serious non-compliance (including those resulting from complaints)	No. of environmental infringement notices issued to suppliers	No. of prosecutions initiated against suppliers
		Defined as a non-compliance without any significant environmental consequences	Defined as a non-compliance that had significant adverse environmental effects		Separated into successful and unsuccessful prosecutions

Recommendation 7: The questions to be asked about the nutrient budgeting target be phrased as follows:

- (i) Do you have a nutrient budget for your dairy farm?
- (ii) If so, who prepared that nutrient budget?
- (iii) Do you use the nutrient budget to actively manage nutrient levels and fertiliser inputs on your dairy farm?

Recommendation 8: In relation to the fencing out of significant wetlands and protection of their natural water regimes:

- (i) The standard of fencing necessary be determined on a case by case basis by the regional authority.
- (ii) The level of protection of the natural water regime that is necessary to protect the wetland also be determined on a case by case basis by the regional authority.
- (iii) Monitoring and reporting of implementation be carried out by regional authorities and forwarded annually to the Ministry for the Environment.

Recommendation 9: In the existing four best practice dairy catchments the existing information be assessed for its ability to ‘explain’ the benefits of implementing the Accord and, subject to ongoing funding, agree a programme to attempt to isolate the benefits of implementing the Accord from the other interventions already being implemented to improve dairy practice.

Recommendation 10: The following catchments make up the ‘Tier 2’ catchments in which the benefits of implementing the Accord will be monitored in depth:

- (i) A selected catchment in the Northland region.
- (ii) The Taharua catchment in the Rangitikei Catchment in western Hawke’s Bay.
- (iii) The Mangapapa Catchment near Woodville in the Manawatu Catchment.
- (iv) The Enaki Catchment, a tributary of the Mangaterere River in the Wairarapa.
- (v) The Motupipi Catchment in Golden Bay.
- (vi) The Rai River (or alternatively the Tuamarina River) in Marlborough (but only to monitor the impacts of improving stream crossings).
- (vii) The Rhodes Stream catchment in South Canterbury.
- (viii) The Washpool catchment, a tributary of the Pomahaka River in southwest Otago.

Recommendation 11: In each of the above catchments:

- (i) Baseline information about dairying land use be collected by Fonterra.
- (ii) Accurate information about progress towards Accord targets be collated by Fonterra.
- (iii) Existing environmental information, such as that on flows, water quality and aquatic ecology, be collated by the regional authority.

Recommendation 12: In each of the above catchments:

- (i) Ongoing information about dairying land use in the catchment be collected by Fonterra.
- (ii) Accurate information about progress towards Accord targets be collated annually by Fonterra.
- (iii) Water quality and biological monitoring be carried out by the regional authority.

Recommendation 13: As a minimum the monitoring programme established in each catchment:

- (i) Comprise at least three sites, one as a control upstream of any influence of dairying.
- (ii) Water quality at each site be monitored monthly for the following parameters: suspended solids, turbidity, volatile suspended solids, conductivity, total phosphate, dissolved reactive phosphate, total nitrogen, nitrate + nitrite nitrogen, ammonia nitrogen, dissolved oxygen and E. coli.
- (iii) The frequency of water quality sampling be increased during summer (January to March inclusive) as this is the time that the greatest benefits from the Accord actions are likely to be recorded.
- (iv) Biological monitoring of macroinvertebrates and algal biomass be undertaken in January or February.
- (v) Intensive monitoring take place for one year to establish base condition, then more extensive monitoring be undertaken for two to three years after which the intensive programme be repeated. This is shown in the following table:

Table 5: Suggested in-stream monitoring regime

Year	Nature of monitoring	Comment
1	Intensive physico-chemical and biological monitoring over summer (January to March); monthly physico-chemical monitoring in other months	Purpose is to establish baseline condition.
2	Monthly physico-chemical sampling in summer; every two months otherwise	More intensive sampling may be necessary if any unusual results are recorded.
3	Monthly physico-chemical sampling in summer; every two months otherwise	More intensive sampling may be necessary if any unusual results are recorded.
4	Either repeat year 1 or continue year two and three programme.	Purpose of repeating year 1 is to establish extent of change
5	Repeat year 1 (if not done in year 4) or continue year 2 and 3 programme.	

Recommendation 14: The detail of the monitoring programme to be carried out in each of the catchments listed in Recommendation 12 be agreed between Fonterra and the relevant regional authority, and included as an Appendix to the Regional Action Plan.

Recommendation 15: Fonterra consider how the best management practices listed in section 9 of this report be included in any future revision of the Dairying and Clean Streams Accord.

11 Acknowledgements

A project such as this cannot be successful without the willing participation of a wide range of people. We are particularly grateful to the help and assistance of Nigel Ironside and Paul McHardy from the Ministry for the Environment, and Charlotte Rutherford, Dr Jim Barnett and Dr John Russell from Fonterra. We also very much thank all those regional authority staff and scientists who freely gave their time to discuss this with us.

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Appendix 1: The Project Brief

Background

The Dairying and Clean Streams Accord is a voluntary industry-led Accord that was signed on 26 May 2003 by Hon Marian Hobbs Minister for the Environment, Hon Jim Sutton Minister of Agriculture, Henry van der Heyden Chairman of Fonterra, and Neil Clarke, Regional Affairs Committee Chairman of Local Government New Zealand.

The Accord aims to improve the health and quality of waterways, including streams, rivers, groundwater, and wetlands, in dairying regions where Fonterra has a presence. Fonterra shareholders represent 96 percent of all dairy farmers in New Zealand. Five targets are set that need to be met by Fonterra within given timeframes. These targets are:

- dairy cattle excluded from 50 percent of streams, rivers and lakes by 2007, 90 percent by 2012
- fifty percent of regular crossing points have bridges or culverts by 2007, 90 percent by 2012
- 100 percent of farm dairy effluent discharges to comply with resource consents and regional plans immediately
- 100 percent of dairy farms to have in place systems to manage nutrient inputs and outputs by 2007
- 50 percent of regionally significant wetlands to be fenced by 2005, 90 percent by 2007.

There are also less tangible ‘roles and responsibilities’ that each of the parties are required to work towards.

The first report on progress towards accord targets was released on 6 December 2004. Ninety-nine percent of farmers took part in the survey to obtain the results in this Snapshot of Progress report, which can also be read online at <http://www.mfe.govt.nz/publications/land/dairying-clean-stream-accord/index.html>.

Scope

In order to support the Accord, the Accord partners wish to develop and implement a long-term monitoring and reporting strategy. The long-term reporting strategy will have two main purposes, identifying:

- progress towards meeting the targets of the Accord
- how effective, in terms of environmental outcomes, meeting the Accord targets has been across the country.

The monitoring and reporting strategy will identify the various data sources and how they will be used to build up a ‘picture’ of what has been done to implement the Accord across the country and the environmental outcomes that have arisen from meeting these targets. For both main tasks, the monitoring and reporting strategy will specify:

- the data sets or information to be used to build this ‘picture’
- any ‘gaps’ that occur in the current monitoring information available. Particularly, the ability of the available information to provide a comprehensive picture across the country, or its ability to identify cause and effect relationships with the implementation of the Accord
- the roles and responsibilities of each of the main Accord parties in the collection, analysis, interpretation, collation and dissemination of the monitoring results
- the timeframes for public reporting.

Monitoring progress against Accord targets

Monitoring the progress towards meeting the five targets of the Accord can be loosely described as the ‘public’ aspect of the long-term reporting strategy. While progress towards the targets is of interest to the Accord partners, it will also provide tangible evidence for the general public of the commitment of the partners towards on-the-ground actions and improvements.

Monitoring progress of the Accord against the set targets will primarily be carried out by Fonterra through their annual on-farm environmental and animal welfare surveys. However, the monitoring and reporting strategy will also need to identify any corroborative monitoring information being collected by other parties.

Monitoring the environmental effectiveness of Accord targets

This second part is important as it gives a measure of the ‘effectiveness’ of the Accord in meeting its overall aim of *‘improving the health and quality of waterways, including streams, rivers, groundwater, and wetlands, in dairying regions where Fonterra has a presence’*.

Monitoring of the effectiveness of the Accord is unlikely to involve the design and implementation of additional monitoring programmes by the Accord partners. Rather, it will seek to utilise existing monitoring information currently being collected to provide a quantitative or semi-quantitative ‘indication’ of the effectiveness of the farmer’s efforts. Having said this, the results of the gaps analysis may be used to revise or refine existing monitoring programmes to ensure the existing monitoring effort provides suitable information to monitor the environmental outcomes of the Accord. These negotiations are outside the scope of this brief.

The environmental outcomes of the Accord are potentially extensive. The strategy will need to consider at least the following:

- the cumulative benefits, or otherwise, of implementing Accord targets, e.g. catchment scale water quality, aquatic and terrestrial ecosystems, biodiversity etc
- the benefits, or otherwise, of implementing measures at an individual farm level including both environmental (surface and groundwater quality, biodiversity etc) and long-term farm sustainability (soil health, impacts/changes in overall farm management)
- trends in dairying on a regional and farm basis.

The contractor will also be required to determine the ‘appropriateness’ of any data source selected for assessing the effectiveness of the Accord. Factors to consider when determining this include:

- whether the data set can be obtained over the entire country or just in certain regions
- the compatibility of the methodology used in obtaining the data across the country
- how effectively the data measures the environmental effects of implementing Accord targets.

Preliminary work has been done to identify relevant data sources across the country. The results of this will be made available to the contractor. However, it will be the responsibility of the contractor to complete this task and to document all information sources identified/considered.

Farmer perception of the Accord

Farmer perceptions and future intentions information is not a requirement of this monitoring strategy. A survey methodology is currently being developed and will be undertaken as part of a Masters student thesis.

Tasks

In compiling the first draft of this strategy, the consultant shall:

- survey all Accord parties to compile a list of potentially suitable information sources/monitoring programmes, including the detailed design of each
- survey NIWA, Crown Research Institutes (Landcare, Crop and Food, AgResearch, etc), Dairy Insight, Dexcel and relevant universities to compile a list of potentially suitable monitoring or research programmes, including the detailed design of each
- develop an assessment framework to assess the suitability of each data set
- undertake the assessment of all information sources in accordance with the assessment framework
- undertake a gaps analysis to identify gaps in both the spatial coverage of appropriate monitoring across the country and/or the ability of existing monitoring to be used to specifically to monitor the effects of the Accord
- develop an appropriate monitoring and reporting strategy to meet the objectives outlined above.

Deliverables

After one month, the contractor will present the gaps analysis to a workshop, organised by MfE. The workshop will involve representatives from regional councils. From this workshop, the draft monitoring and reporting strategy will be developed.

At the conclusion of the contract, a draft of a long-term reporting strategy for the Dairying and Clean Streams Accord will be provided to the Ministry for the Environment. The Ministry for the Environment will further discuss and develop this draft with the Ministry of Agriculture and Forestry, Fonterra, and regional councils.

Appendix 2: Summary of Responses from Regional Authorities

As part of the process of preparing this strategy interviews were carried out with staff from the 13 relevant regional authorities. The main points made in those interviews were:

- Almost all regional authorities strongly support the Accord. While most councils voiced some criticism of the Accord targets, and particularly their lack of precision, all see the Accord itself as a significant step forward by Fonterra. There was much favourable comment about it being an industry-led initiative.
- Councils were roughly divided in half between those who saw the Accord as making either a little, or a reasonable amount of, difference to their regional environment. Importantly, almost all councils did, however, comment that the Accord has changed the attitude of most farmers, and some observed that it is making their regulatory job much easier, particularly in relation to stock access to water courses and provision of stream crossings. Some councils also commented that the Accord has encouraged farmers to prepare farm plans that look at sustainable management on their properties, and that the Accord was an element of wider initiatives by farmers to improve their environmental performance. In other words, one of the major benefits of the Accord has been to change attitudes among dairy farmers to environmental management and protection.
- Some councils were critical that the size of streams to which stock access is to be restricted under the Accord is subject to variability in measurement (is it, for instance, measured during high, average or low flow conditions). Councils generally observed that the Accord water courses make up only a proportion of those actually located on farms, with ephemeral, first order and second order streams unlikely to be included in the Accord's on-farm actions.
- Many councils saw the Accord targets as being too open to interpretation and felt those targets should be better defined. There was a general consensus that the targets did not necessarily go far enough in determining exactly what the objectives were, making environmental outcomes difficult to achieve.
- Most councils were keen to go further than the Accord targets in improving the management of non-point source discharges from dairying. Two commonly cited examples were encouraging fencing of smaller water courses, even if only by single strand electric fencing, and encouraging planting of fenced riparian margins with native vegetation. Many councils also promote farm management planning, and see implementation of the Accord as part of that wider objective. In other words, implementation of the Accord is just part of a wider range of activities councils promote to mitigate the effects of dairying on the environment.
- Most councils listed faecal contamination, nutrients and suspended sediment as the main water quality issues in lowland surface water bodies in their regions.

- Environment Canterbury observed that the main water quality concerns in their region were nitrate-nitrogen and faecal contamination of groundwater, and that this is not addressed comprehensively by the Accord. Several other councils (Manawatu-Wanganui, Wellington, Waikato) expressed the same concern for some discrete parts of their regions.¹⁵
- All councils supported the current project to prepare a national monitoring and reporting strategy, and most were keen to see some specific monitoring undertaken in their region, provided in some cases they did not have to pay the full costs of doing so.

¹⁵ Compliance with consent or permitted activity conditions to discharge to land will generally help limit nitrogen leaching, as there is usually a requirement to limit application rates to say 150–200 kg/N/ha/y. Similarly, the preparation of on-farm nutrient management plans should limit nitrogen leaching rates to groundwater.

Appendix 3: The Best Practice Dairy Catchments

The best practice dairy catchments for sustainable growth project commenced in 2001. There are presently four such catchments in those parts of the country where Fonterra operates. These have typically been studied intensively for four to 10 years. They are the Toenepi Catchment near Morrinsville in the Waikato, the Waiokura catchment in South Taranaki, the Waikakahi catchment on the north bank of the lower Waitaki River, and the Bog Burn Catchment in eastern Southland.

These four catchments were selected because they are predominantly dairying, and they cover a range of geographic locations and climate types around New Zealand. Production levels are typically above the national average, most farmers purchase additional feed, and fertiliser use is typical of other dairy farms in New Zealand.

As part of this project a review was carried out of existing monitoring programmes in these catchments, which are summarised below. It is also noted that a joint monitoring programme currently being undertaken as part of the National Catchment Dairy Project (Environment Waikato, NIWA, Dexcel and Ag Research) has undertaken significant work in the Toenepi Catchment which has resulted in a number of Farm Action Plans being developed. This work is based on a significant amount of monitoring information and Fonterra expect that the 'template' will now be utilised within the other catchments.¹⁶

A wide variety of research work has been undertaken in the four best practice dairy catchments. It is very important to note that this work has focused on monitoring of water quality, and best practice dairying through intensive studies linking environmental outcomes, farm inputs and farm productivity and economics. In no case, however, has this work directly focused on the benefits of implementing the Accord. In the following reviews of the work undertaken to date we only discuss the work with an environmental emphasis.

1 The Toenepi Catchment

The catchment

The Tonepi catchment covers some 15.5 km² of rolling country towards the east of the Waikato, near Morrinsville. Almost two thirds of the catchment is in dairying with 21 farms present. The balance of the catchment is more or less equally divided between dairy run-off and drystock. In 2001, the average herd size was 211 and the stocking rate was three cows/ha, and no stock were wintered off-site.

¹⁶ Another catchment at Inchbonnie near Lake Brunner has recently been added to this programme. As it is outside the Fonterra ambit, however, it is not suitable for including as part of monitoring the benefits of implementing the Accord (unless Westland Dairy comes up with a similar arrangement with their suppliers).

Average rainfall is 1200mm, mean flow is 70l/s, and there is 39.4 km of stream length present. Of this, 56 percent is permanently fenced on one side, six percent permanently fenced on both sides with 25 percent of stream length both fenced and the riparian zone planted. Eighty-six percent of the farmers in the catchment dispose of their dairy effluent to water after pond treatment, with the balance irrigating to land.

Monitoring to date

The Toenepi catchment has been the longest studied of the four best practice catchments, having been studied since 1995. Weekly sampling of water quality at three sites in the catchment was carried out for two years from March 1995 to April 1997. Sampling frequency was reduced after this, but monthly monitoring of many variables continues to this day. A permanent flow recording site is present at the lower end of the catchment.

As in all four of the best practice catchments, there is a vast amount of water quality information available from analyses of all the water quality samples collected in the catchment. This information is summarised in Wilcock and Duncan (2003). This work, which has taken place over the last 10 years, generally shows water quality to be significantly degraded, more so than in the other three catchments.

In broad terms, although levels of suspended solids are generally low, they are sometimes elevated as is turbidity. Nutrients are elevated, and in the case of phosphate, increase downstream. Specific yields of nutrients are the highest of the four catchments, which may well reflect the higher dairy stocking rates in the Toenepi versus the other catchments. Specific yields of suspended sediment and nutrients dropped, typically between 20–40 percent, between the years 1995–97 versus 2001/02. Levels of *E. coli* are high, and regularly exceed contact recreation guidelines. There are occasional records of low dissolved oxygen and high levels of ammonia nitrogen.

In spring 2001, as in the other best practice catchments, soil physical, chemical and biological quality assessments were made of the major soil types within the catchment (Mongahan et al 2001). About two-thirds of the soils in the Toenepi were compacted, and Olsen P, which averaged 53, was considerably higher than the target of 25–35.

This work was repeated in winter 2003 (Drewery et al 2003). At this time, soil compaction was evident on 43 percent of farms, and again Olsen P was high on most properties, exceeding 40 in 70 percent of the properties in the catchment. Many sites had lower than optimum soil potassium.

There are three main sources of phosphate entering the water courses in the catchment, with each of soil loss, excessive phosphate fertility and discharges from dairy effluent ponds each making up approximately 30 percent of the phosphate running off farms.

2 The Waiokura Catchment

The catchment

The Waiokura catchment rises on the south Taranaki ring plain near Kaponga and flows south to enter the sea near Manaia. Mean flow is 313 l/s. In 2001, there were 17 dairy farms in the catchment with an average herd size of 256 and an average stocking rate of 3.4 cows/ha. Twenty-nine percent of stock are wintered off-site.

Two-thirds of the farmers in the catchment irrigate to land, with the other third discharging to water after pond treatment. Of the total stream length, 38 percent has riparian fencing on both sides, 31 percent on one side and 31 percent of the streams are both fenced and planted out with riparian species.

Monitoring to date

Intensive work has been carried out in the catchment since 2001. Fortnightly sampling of water quality is carried out at three sites in the catchment by the TRC, and a permanent flow recording site is present at the lower end of the catchment.

As in all four of the best practice catchments, there is a vast amount of water quality information available from analyses of all the water quality samples collected in the catchment. This information is summarised in Wilcock and Duncan (2003). This work, which has taken place over the last five years, generally shows water quality to be significantly degraded.

In broad terms, although levels of suspended solids are generally low, they are sometimes elevated as is turbidity. Nutrients are also somewhat elevated, particularly phosphate at the upper site in the catchment. Levels of *E. coli* are high, and regularly exceed contact recreation guidelines. Dissolved oxygen is generally high and levels of ammonia nitrogen low.

In spring 2001, as in the other best practice catchments soil physical, chemical and biological quality assessments were made of the major soil types within the catchment. Olsen P, which averaged 65, was much higher than the target of 25–35. The volcanic soils in the catchment are not subject to compaction.

This work was repeated in winter 2003. Olsen P was high on almost all properties, exceeding 40 in 95 percent of the properties in the catchment. Many sites had lower than optimum soil potassium.

There are three main sources of phosphate entering the water courses in the catchment. Excessive phosphate fertility makes up about 40 percent of this, whereas discharges from dairy effluent ponds and soil loss each making up nearly 30 percent of the phosphate running off farms.

3 The Waikakahi Catchment

The catchment

The Waikakahi catchment covers predominantly flat pasture on the north bank of the Waitaki River, which it enters near Glenavy on State Highway 1. The stream is sourced predominantly by several large springheads, along with some run-off from the adjacent hill country. Mean flow is 537 l/s, although summer mean flow is 1,850 l/s.

The catchment is atypical in that it is part of the Morven-Glenavy-Ikawai irrigation scheme, which takes water from the Waitaki River. Of the 4,100 ha of flat land in the catchment, about 95 percent is irrigated, 80 percent by border-dyke. This predominantly border-dyke irrigation means that stream flows are much higher in summer (typically four to nine times winter flows) when irrigation by-wash leads to substantial overland run-off to the stream. Catchment soils are light silt loams – they are gravel outwash soils from the former bed of the Waitaki – but have been greatly improved with irrigation and the use of fertiliser. While average catchment rainfall is only about 540 mm per annum, another 810 mm is applied on average via irrigation.

Dairying ‘took off’ in the catchment in the mid 1990s. While there have long been several dairy farms present, there are now 11 dairy farms which cover almost all the lowland parts of the catchment. The average dairy farm size in 2001 was 244 ha with an average herd size of 665 and a stocking rate of 2.8 cows per hectare. Almost two-thirds of these stock are wintered off-site. Three-quarters of the farms dispose of effluent via pond treatment and irrigation, with the balance equally divided between pond treatment and disposal to water, and direct effluent irrigation to land.

The initial impacts of dairying on stream water quality and stream ‘health’ were severe. Unimpeded stock access led to significant siltation of the stony-bottomed bed of the stream, and to declining water quality. The value of the stream for trout spawning, and as habitat for invertebrates, juvenile fish and native species, was much reduced.

Since that time major efforts have been undertaken by Environment Canterbury, Fonterra and the farmers to reduce the impacts of dairying, and so restore water quality and stream health. This has included fencing off over 90 percent of the streams and the major springheads,¹⁷ providing stock crossings, and riparian retirement and planting (22 percent of the stream length is both fenced and planted).

Monitoring to date

Intensive work has been carried out in the catchment since 2001, although some earlier work was carried out by the Regional Council Environment Canterbury (ECan). Monthly sampling of water quality is carried out by ECan at one site, and a permanent flow recording site is present at the lower end of the catchment.

¹⁷ Although the quality of some of the fencing is not high, being very close to the stream in some instances.

As in all four of the best practice catchments, there is a vast amount of water quality information available from analyses of all the water quality samples collected in the catchment. This information is summarised in Wilcock and Duncan (2003).

This work, which has taken place over the last 10 years, generally shows water quality to be significantly degraded. In broad terms, levels of suspended solids are consistently elevated as is turbidity. Nutrients are also elevated, and in the case of phosphate increase downstream, and levels of *E. coli* are high, regularly exceeding contact recreation guidelines.

In spring 2001, as in the other best practice catchments, soil physical, chemical and biological quality assessments were made of the major soil types within the catchment. Overall soil quality was good, although about a third of the soils in the Waikakahi were compacted, and Olsen P, which averaged 46, was considerably higher than the target of 25–35.

This work was repeated in winter 2003. At this time soil compaction was at a low level, but again Olsen P was high on many properties, exceeding 40 in 65 percent of the properties in the catchment. Many sites had lower than optimum soil potassium.

A modelling study carried out in the Waikakahi and Bog Burn catchments showed that the wintering part of the dairy system made disproportionately large contributions to nitrate leaching from farms. These were 25 percent and 60 percent respectively, despite being only 15 percent of the whole dairy farming area. This was attributed to both nitrogen remaining in the soil from previous activities, and nitrogen being excreted on to forage crops when plant growth is low during winter.

A study was undertaken by Carey et al (2003) of the rate of run-off of irrigation wash water from border-dyke irrigation. The main findings included:

- that although a large amount of irrigation water was applied across the land, the rate that which it passed was too high to allow adequate infiltration
- concentrations of the nutrients N and, particularly, P, and *E. coli* in irrigation by wash were consistently higher than acceptable critical levels for water quality
- most phosphate was sourced from high soil phosphate levels, with a need to reduce target levels of Olsen P in the soil.

4 The Bog Burn catchment

The catchment

The Bog Burn catchment, which covers an area of 87.6 km², is in eastern Southland. The catchment rises at an altitude of above 500 m, and is dominated by dairying with some exotic forestry in the headwaters. Catchment soils are heavy and poorly drained. In 2001, there were six dairy farms in the catchment with an average herd size of 748 and a stocking rate of 2.9 cows/ha. All dairy stock are wintered off-site. Forty percent of the stream length in the catchment was fenced on both sides, 40 percent on one side only and 20 percent of the stream length was riparian fenced and planted. All six farms dispose of dairy effluent to land; two do so directly and four do so following pond treatment.

In the year starting January 2002, stream flows varied from 44 to 5186 l/s. Mean flow was 389 l/s and median flow was 163 l/s.

Monitoring to date

Fortnightly sampling of water quality and sediment was carried out by Environment Southland at three sites during 2002. Water quality samples were analysed for suspended sediment, DRP and TP, and sediment samples for suspended sediment, TP and BAP (bioavailable phosphorous).

Results are reported by McDowell and Wilcock (2004). Levels of phosphate were highest in the water column and in sediment during summer and autumn, and lowest in winter and spring, and generally increase downstream. Sediment entering the stream is sourced primarily from topsoil, and enters via tile drains or, to a lesser extent, overland flow. Direct drainage via mole drains of irrigated dairy effluent contributes one third of the total phosphorous loading to the stream. Phosphorous is considered to enter primarily from the same sources, and exceeds levels desirable for good water quality. It was suggested that management focus on reducing sources of phosphate entering tile drains, primarily by reducing soil Olsen P levels. Levels of *E. coli* are high, regularly exceeding contact recreation guidelines.

In spring 2001, as in the other best practice catchments, soil physical, chemical and biological quality assessments were made of the major soil types within the catchment. Although overall soil quality was good, about a third of the soils in the Bog Burn were compacted, and Olsen P, which averaged 42, was higher than the target of 25–35.

This work was repeated in winter 2003. At this time soil compaction was at a moderate level, and Olsen P was high on some properties, exceeding 40 in 43 percent of the properties in the catchment. Many sites had lower than optimum soil potassium.

Appendix 4: Base Information from a Proposed Tier 2 Catchment

This is an example of base information from one of the suggested additional monitoring catchments.

Catchment	Water quality monitoring	Biological monitoring	Flow data available	Comments
Taharua (tributary of Mohaka River), Hawke's Bay	Quarterly sampling for: <ul style="list-style-type: none"> • electrical conductivity • ammoniacal nitrogen • dissolved inorganic nitrogen • total phosphorous • pH • dissolved oxygen • total organic carbon • visual clarity • water temperature Monthly sampling for: <ul style="list-style-type: none"> • total nitrogen • nitrate nitrogen • dissolved reactive phosphorous • faecal coliforms • total suspended solids 	Annual sampling for: <ul style="list-style-type: none"> • ash free dry weight • chlorophyll a • macroinvertebrates 	Yes	Two farms Three monitoring sites Background level (upstream) site available Five or six years of record at each site No additional instream monitoring required to align with strategy recommendations